Active Project (2016 - 2017)

Fiber Optic Health Monitoring of 3D Woven Preforms and Composites Employing Structurally Integrated Sensors, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Woven TPS (WTPS) is an attractive option for thermal protection because it allows for a design to be tailored to a specific mission ? material composition can be adjusted by weaving different fiber types together and controlling their placement using computer-controlled, automated, 3D weaving technology. NASA?s HEEET program is responsible for the development of WTPS, with the objective of enabling a broad range of missions. With complex material systems such as WTPS, there exists a need for in situ Structural Health Monitoring (SHM) capability designed to diagnose and report any degradation in the capability of the structure. The primary objective of the proposed effort is to leverage MR&D?s micromechanics-based Program Suite to interpret measured temperature and strain data derived from fiber optic sensors that are structurally integrated in a 3D woven composite panel. Specifically, measured strains at the constituent level will be used to compute a local stress state in several 3D woven composite test specimens under a variety of thermal and structural loads. Measured temperature data will dictate which temperature-dependent constituent material properties to use in the micromechanics model. The proposed research offers a software solution for providing a physics based interpretation of sensor data acquired at the constituent level of a 3D woven structure and computes an effective composite level response for the purposes of evaluating structural health in near real time.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The successful completion of the Phase I program would directly benefit the Adaptable, Deployable Entry and Placement Technology (ADEPT) program as well as the HEEET Woven TPS program, both of which are currently focused on the use of 3D weaves in

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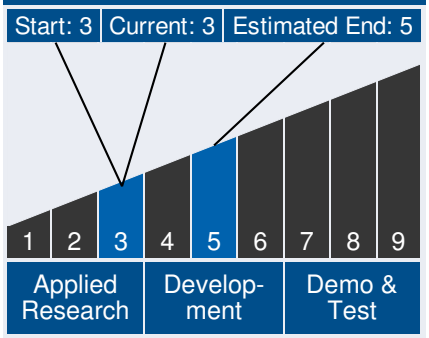
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

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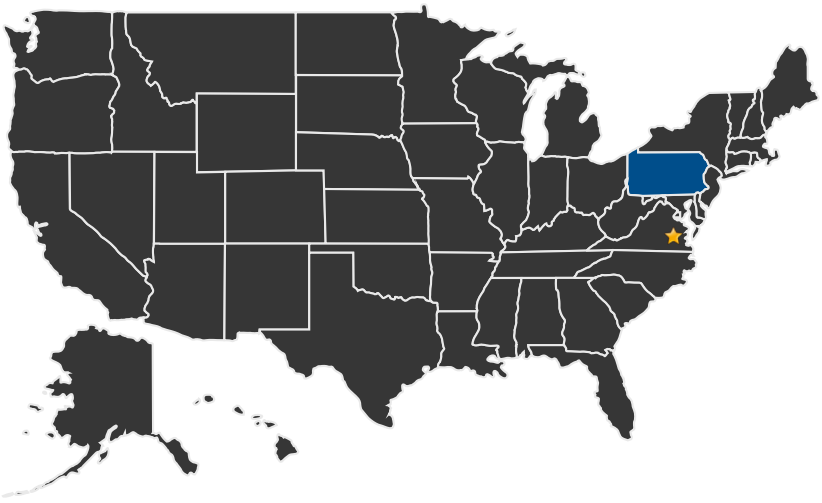
ablative TPS. The pairing of fiber optic sensor measurements with analytical software tools ? which can rapidly translate measured yarn-level strain and temperature changes to compute a composite level response ? allows for a robust, widely applicable, SHM tool.

To the commercial space industry:

Potential Non-NASA Commercial Applications: There are potential applications of the SHM software tool developed under the proposed effort to be used within the Department of Defense (DoD). The use of 3D woven preforms in ballistic armor applications creates a need for real-time SHM focused on diagnosing and reporting degradation to a composite system.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Langley Research Center

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

Principal Investigator:
- Gary Tiscia

Technology Areas

Primary Technology Area:
Materials, Structures, Mechanical Systems and Manufacturing (TA 12)
- Structures (TA 12.2)
  - Reliability and Sustainment (TA 12.2.3)

Other Organizations Performing Work:

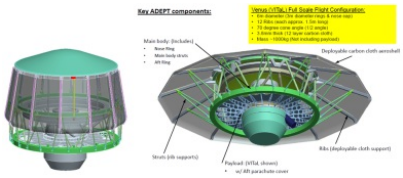
- Materials Research and Design, Inc. (Wayne, PA)
- VILLANOVA UNIVERSITY IN THE STATE OF PENNSYLVANIA (Philadelphia, PA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23533)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

Fiber Optic Health Monitoring of 3D Woven Preforms and Composites Employing Structurally Integrated Sensors, Phase I

Potential Applications

The successful completion of the Phase I program would directly benefit the Adaptable, Deployable Entry and Placement Technology (ADEPT) program as well as the HEEET Woven TPS program, both of which are currently focused on the use of 3D weaves in ablative TPS. The pairing of fiber optic sensor measurements with analytical software tools ? which can rapidly translate measured yarn-level strain and temperature changes to compute a composite level response ? allows for a robust, widely applicable, SHM tool.